DISCARDED AND ABANDONED AQUACULTURE CLAM NETTING ON THE ATLANTIC BARRIER ISLANDS ON THE EASTERN SHORE OF VIRGINIA

2004 REPORT

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The views expressed herein are those of the Virginia Eastern Shorekeeper and do not necessarily reflect the views of NOAA or any of its sub-agencies or the Virginia Department of Environmental Quality.

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Cover photo: Workers tending their clam net near Revel's Island, Virginia, with clam net overlay. Photo by R. Ayers, 2004

Photo enhancements: In no case was the content of any image or photo used as a figure changed or modified. Where noted some digital photos shown as figures were enhanced using Adobe Photoshop 6.0 to highlight a portion of the photo. Contrast and brightness level were adjusted to make images of the photos more recognizable. In some pictures all or some of the color was removed to highlight areas and to reduce overall image/pixel size. Except where cited all photo were by R. Ayers, 2004

INTRODUCTION

Reports by island land managers indicate a substantial amount of plastic netting used in the clam aquaculture industry has been reported on coastal barrier beaches and seaside marshes. Little is known about the quantity of clam netting on the seaside of the Virginia Eastern Shore. This assessment will begin to provide some measurement of the quantity and location of the netting on these barrier beaches and begin the discussion of their cumulative and secondary impacts to the coastal ecosystem.

Defined objective: Document human impacts to sensitive marine resources
The objective was to locate, assess, and document the extent of discarded plastic netting used in the clam aquaculture industry. The assessment will provide the basis for periodic public forums involving aquaculturists, residents, county officials and representatives of regulatory agencies to discuss and recommend remedial measures. The report will photo document and map the location and observed effects on the coastal system. In addition, the report will include public comment on the scope, impact and suggested remedies in addressing the discarded and abandoned plastic aquaculture netting on Virginia's seaside.

Background
Aquaculture is the fastest growing segment of U.S. agriculture. In 2000, the farm value of the U.S. aquaculture industry was estimated at nearly $1 billion dollars. In Northampton County clams are second only to tomatoes in their agricultural value (Northampton County Extension Service 2003). The clam aquaculture industry represents a significant fishery on Virginia's seaside (Figure 1). Because no permits are required to grow aquaculture clams in Virginia it is difficult to access the total number of clams being grown. Bottom leases are required, but do not necessarily reflect any particular use. The clam aquaculture industry is eligible to apply for crop insurance through the USDA for planted clams. Changes in crop insurance policies over the past few years have caused some smaller independent growers to forgo insurance. Crop insurance figures suggest that there are 550 million clams planted around the Eastern Shore of Virginia. This includes both the seaside and Chesapeake Bay side with no clear way to break down the numbers. Some "best guesses" suggest there may be closer to 600-650 million clams planted on the Eastern Shore of Virginia.

Figure 1. Clam growers working near Smith Island, Virginia.

Shellfish aquaculture, specifically the term clam aquaculture, includes shellfish spawned in a hatchery, raised in a nursery, stocked onto private leases for grow out, and then harvested. The hard clams grown on the Eastern Shore of Virginia are from the genus *Mercenaria* and grow in the near-shore waters from Maine to Florida. Locally, clams are known by a number of names, most often referring to a size and not a different species of clam. Names include; clams, hard clams cherrystones, littlenecks, topnecks, chowders and quahogs.

In clam aquaculture, three different systems are used during different phases of the clam's life (Figure 2). They are: 1) the hatchery phase that is designed to provide the ideal growing conditions for the brood stock. Select clams are spawned and grown to a specific size in hatcheries. The size of these young clams is controlled by screening out specific size clams. 2) In the nursery phase growers on the Eastern Shore have

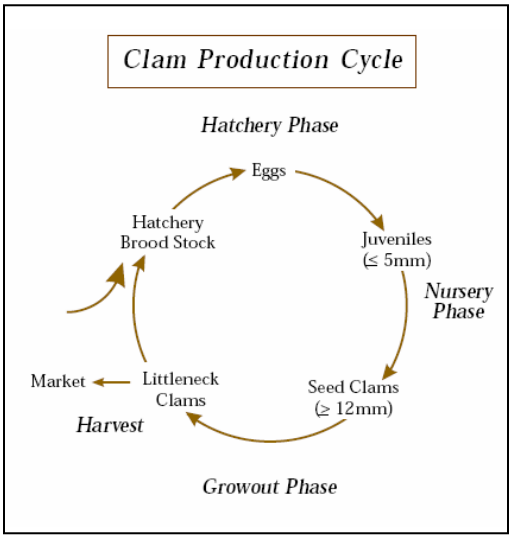

Figure 2. Clam Production Cycle (North Carolina Dept. of Agriculture 2001)

historically used land-based raceways. The raceway systems typically utilize long, shallow wooden or fiberglass trays which have been lined with plastic or covered with epoxy resin coatings. Large round tubes with various mesh filters lining the bottoms are lined up along each tray, over which the juvenile clams are distributed. Raw seawater is pumped into each tube at a prescribed rate across the clams. The second method used in the nursery phase is the field-based system, which involves placing seed clams from the hatchery or land-based nursery into submerged bottom trays. Traditional designs employ subtidal and intertidal trays made of plastic and have a protective cover of fine mesh netting to discourage predators. The third, becoming more prevalent on the seaside, is the bottom nursery. This method essentially takes nursery size clams and places them on a sandy bottom. The small clams, around 5 mm, are then covered with a small mesh (1/6 inch) predator net. 3) The final phase, grow-out, is the time between planting seed clams and harvesting market size clams. The time will largely depend on water quality, food availability and temperature. Clams prefer water with a relatively high and stable salinity, and grow best where waters have about two-thirds of the salinity of the ocean (about 25 ppt.). Clams also prefer an area with active tidal flushing; tides mix oxygen throughout the water column, wash away waste and silt that can smother clams, and deliver supplies of microscopic algae which the clams eat. Growth is influenced by water temperature, availability of food, planting densities, disease and predation. An18 to 36 month grow-out period is necessary for seed clams to reach a market size of 45 to 50 mm in shell length, or one inch thick.

Figure 3. Clam bed exposed at low tide, note gravel bags in foreground of net holding down the edge.

Although land-based grow-out methods such as raceways and tanks have been developed, field-based grow-out methods are better suited for hard clam production. Most field based grow-out operations utilize some form of pen, tray, soft bag or net. On the Eastern Shore of Virginia nets in subtidal and intertidal zones are the most common. Seed clams are planted in beds approximately 14 x 50 feet. Each bed may be planted with 40,000 to 50,000 seed clams. Nets are placed over the beds where seed clams are planted. The edges of the net are weighted down with steel rebar or weighted gravel bags as a means to keep the net in place and discourage predators (Figure 3). Harvesting is accomplished by removing or rolling the net from the planted areas and exposing the clams to harvest by legal bottom harvesting.

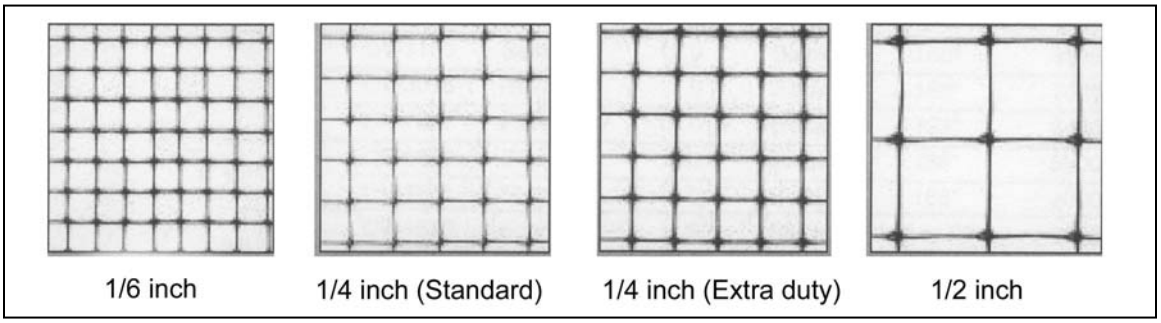

Figure 4. Shown common clam aquaculture net mesh sizes. (InterNet® Inc., 2004)

For the purpose of this report the net with a mesh size of 1/6 to 1/8 inch will be referred to as ”nursery net.” All other netting used by the clam aquaculture industry will be referred to as “clam net” (Figure 4). This will be black or white net with a mesh size from ¼ to ½ inch in size. Other types of netting, not used by the clam aquaculture industry will be referred to by their common names; gill net, cast net, sand fence, etc.

Nets are used solely to protect clams from large predators. Skate, Summer Flounder, Stripped Bass, Black Drum, star fish, conch, Blue Crab and Atlantic Brant and most gulls are among the common larger predators on the seaside. Most of the netting reported in use on the seaside is an oriented polyethylene or

polypropylene mesh that has a UV additive to extend outdoor life. Most of the netting reported in use by the clam aquaculture industry on the seaside in produced by two suppliers. One supplier, Tenax® , provides all the white ¼ inch net. The other supplier, InterNet®, provides all the black net in various sizes. Common net widths are 14 feet (168 inches) with some manufacturers providing net in 16'5" (197 inch) widths. Net is sold in a variety of roll lengths up to 5000'. Typically, most growers on the seaside use nets cut to a length of 50 to 60 feet, though some private growers use nets as short as 20 feet. Nursery nets have been observed in lengths from 20 to 100 feet.

METHODS

The primary survey method conducted during 2004 was a simple Beach Survey (Figure 5). This survey documented the presence of netting on Atlantic barrier beaches and evaluated potential impacts on beach nesting birds and sensitive beach grasses. Sampling was conducted in the spring and late summer to minimize potential disturbances to island nesting birds.

Figure 5. Shorekeeper conducting beach survey locating large portion of abandoned clam net (D. Field, DCR/DNH 2003)

The Virginia Eastern Shorekeeper and its volunteers conducted all the surveys. Landowners were notified, and where appropriate, research permits were obtained. Primary property owners include; Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR/DNH), Virginia Marine Resources Commission (VMRC), U.S. Fish & Wildlife Service (USF&WS), Eastern Shore National Wildlife Refuge and Fisherman Island National Wildlife Refuge, The Nature Conservancy (TNC), Virginia Chapter and several private landowners.

Geographic area includes Northampton County, VA, Atlantic coast and coastal bays; and Accomack County, VA, Atlantic coast and coastal bays south of Gargathy Inlet. To evaluate sampling methods two beach sites were chosen on the Chesapeake Bay. In addition, random sampling was conducted while on the water in the entire Seaside Heritage Program area (Figure 10). The northern end of Metompkin Island, owned by USF&WS, was surveyed by boat. Because of the islands' low profile and low number of observed nets, a research permit was not deemed necessary

Although Beach Surveys were primary, two secondary surveys were conducted to supplement data. A Targeted Survey focused sampling in selected areas of public land managed by Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR/DNH). These were planned to be sampled monthly to more closely monitor netting impacts. Wreck Island Natural Area Preserve (WINAP) was selected to evaluate coastal beach, high marsh and salt marsh habitat along the Atlantic coast. Sampling was suspended during July and August because of concerns over disturbance of a large Tern/Skimmer colony. Savage Neck Dunes Natural Area Preserve (SNDNAP) was selected to evaluate bayside beaches with secondary dunes and coastal maritime shrub. Surveys were conducted with DCR/DNH staff during the summer months while northeastern beach tiger beetles (*Cicindela dorsalis dorsalis*)are active. Random Sampling was conducted on the entire Atlantic seaside and on the bayside along Plantation, Elliots and Cherrystone Creeks. This sampling was conducted in conjunction with normal on-the-water Shorekeeper activities. Approximate position and description of netting observed on private lands was estimated from the boat and was not tagged. Free floating nets and unobstructed nets located in fringe or edge marsh was positioned and collected for proper disposal.

A spring beach survey was requested on Fisherman Island NWR on 14 March 2004 to coincide with the Fisherman's Island beach cleanup. On arrival, the island was partially closed because of an early nesting American Oystercatcher. Beach surveys were conducted only on approximately one mile of the island. Because of the incomplete spring survey, a fall survey was not conducted on Fisherman Island NWR.

All beach surveys were conducted on foot. Surveys collected information on location, net description and habitat information. Nets were marked and numbered with biodegradable tagging. A handheld GPS unit (Garmin 12MAP) was used to determine net location. In many cases the net was almost completely buried in sand or debris. No attempt was made to dig out or overly disturb the net or the surrounding habitat. Generally on barrier beaches the surveyor walked the high tide or "wrack line" looking for netting. On wider beaches and beaches without a substantial primary dune, the survey also explored recent over-wash areas to look for netting driven into interior or high marsh by storms (Figure 6). GPS waypoints were recorded and downloaded into the Garmin MapSource, version 6.3, software for mapping.

Figure 6. Locating net with handheld GPS unit

Marking the net:

Each accessible net found during the beach survey was tagged using an eight inch colored nylon wire tie; the spring survey used Blue (**BL**) ties on net when first tagged, and smaller yellow (**YL**) ties during spring retagging. The fall surveys used Green (**GR**) ties north of New Inlet and Orange (**OR**) ties south of New Inlet (Table 1). For tagging: ¾" x 3" aluminum forestry tags were attached with the colored nylon wire tie (Figure 6). Tags were Forestry Suppliers "Al Tag" Double Faced Aluminum Tags, Item number 79500. These tags were used because they were field markable, and the manufacturer indicated that debossed markings would remain visible regardless of weather, grease, pitch or dirt. The tags would also biodegrade after a few years. Each tag was marked with a two-letter location identifier followed by a three-digit number (Table 1) (Figure 7).

Tag # AA000-XX999

MT	Metompkin Island		
CD	Cedar Island	**AM**	Atlantic Marsh
PM	Parramore Island NAP	**AS**	Atlantic Shoreline
RV	Revel's Island	**AX**	Atlantic Open Water
HG	Hog Island		
CB	Cobb's Island	**BM**	Bayside Marsh
LC	Little Cobb Island	**BS**	Bayside Shoreline
WK	Wreck Island NAP	**BS**	Bayside Open Water
SS	Ship Shoal Island		
MM	Mink/Myrtle Island	**SN**	Savage Neck NAP
SM	Smith Island	**TR**	Trower Bayshore NAP
FM	Fisherman Island NWR	**PK**	Parker's Marsh NAP

Flag Color	
BL	Blue
GR	Green
YL	Yellow
OR	Orange

Net Color	
B	Black
W	White (off white)

Mesh Size	
S	< ¼" (nursery)
M	= ¼" (normal)
L	> ¼" (unusual)

Net Size		
	S	Net will easily fit into a clam basket
	M	Net could be stuffed into a clam basket
	L	Net would not fit into a clam basket
	W	Whole or nearly whole net, 15' x 100'

Table 1. Field definitions used in 2004 net surveys.

Figure 6. Flagged net with tag on Fisherman Is NWR

Figure 7. Tag “WK001” on Wreck Island NAP

The tags were attached by the wire tie at a visible high point on the net. The soft aluminum tags held up well in the salt air but were highly susceptible to damage and even removal by large birds, primarily gulls. After having some tags damaged and destroyed by birds, subsequent tags were placed under or protected by the net, but still visible near the highest point.

Figure 8. Large section of white clam net on upper beach. Net is beginning to sand in. Area of disturbed sand is the result of birds foraging in and around the net.

An approximate size was given to all sampled netting. This was subjective because the actual length of clam net varies by grower and the netting was often buried in the sand or covered in wrack (Figure 8). However, a simple grouping of; Small (**S**)(net will easily fit into a clam basket), Medium (**M**)(net could be stuffed into a clam basket), Large (**L**)(net would not fit into a clam basket) and Whole Net (**W**) was used (Table 1). A standard plastic clam basket was used as the size reference. Whole net was most often determined by size, unbroken edging and lack of any significant damage, particularly on the ends. Nets less than one square meter are not surveyed or tagged.

The net color was recorded. Only two colors, black (**B**) and white (**W**) were noted. White net often appeared tan when covered with growth. The net mesh size was recorded. The definitions for net size were; ¼" Mesh (**M**), Smaller than ¼" (**S**), Larger than ¼" (**L**).

Habitat		Additional definitions
OW	Open Water	Includes surf zone.
LB	Lower Beach	Includes shoreline and intertidal zone.
WL	Wrack Line	Includes the clear debris line from recent high tides.
UB	Upper Beach	The beach strand above high tide line.
DUN	Dune	Includes primary dunes, secondary dunes and shell piles
SHR	Shrubs	All areas of shrubs and trees, including shrubs on dunes
CB	Clam Beds	Active clam beds and accessories, i.e. piles, poles, trays, etc.
TF	Tidal Flats	
LM	Low Marsh	Salt marsh, includes fringe marsh and cordgrass dominated marsh
MM	Marsh Wrack Line	The clear debris line from high tides
UM	Upper Marsh	Marsh above "normal" tide line
MAN	Man Made	Piers, bulkheads, pilings, bridges, docks or other manmade objects.

Table 2. Field definitions for habitat used during the 2004 net survey.

A general description of the habitat where the net was located was recorded. Table 2 provides details of field definitions. Net coverage was added to the fall survey. A 0-100 percent scale of net covered by sand or debris was used. In most cases this was an estimate and was generally recorded in increments of ten (*i.e.* 20, 50, 60 *etc.*). Unusual observations were also noted. Digital photographs were taken to document various effects of netting on coastal habitat. In most cases digital pictures were in a 2 mega pixel format for good picture quality. In some case a small (3" x 5") card was used to show a large readable tag number to aid in later identification (Figure 9).

Figure 9. Temporary net marking for photographs

RESULTS

Five hundred sixty-one pieces of discarded or abandoned clam net were surveyed within the Seaside Heritage area during the 2004 survey. A total of 387 pieces of net were marked on the barrier island beaches, from the north end of Metompkin Island to the south end of Smith Island. Ninety-four percent of the netting on the island beaches was located south of Quinby Inlet just south of Revel's Island. 195 nets (approximately ½) were tagged during the spring survey and were not seen again. 128 nets (approximately 1/3) were tagged in the spring survey and subsequently re-tagged during the fall survey. Only 64 new nets (approximately 1/6) were found during the fall survey. An estimated average of 119,500 square feet of discarded clam net was on the barrier beaches during 2004.

Figure 10 shows the average clam net distribution on barrier island beaches for 2004. Though information was collected on a per island basis, distribution is shown in five nautical mile increments to better represent overall coastal beach distribution. Smith Island had the largest average number of clam nets with 84 pieces, followed by Wreck Island NAP with 71 pieces and Hog Island with 64 pieces. Cobb's Island only averaged 40 pieces of clam net. Metompkin Island, Cedar Island, Dawson Shoal, Parramore Island NAP and Revel's

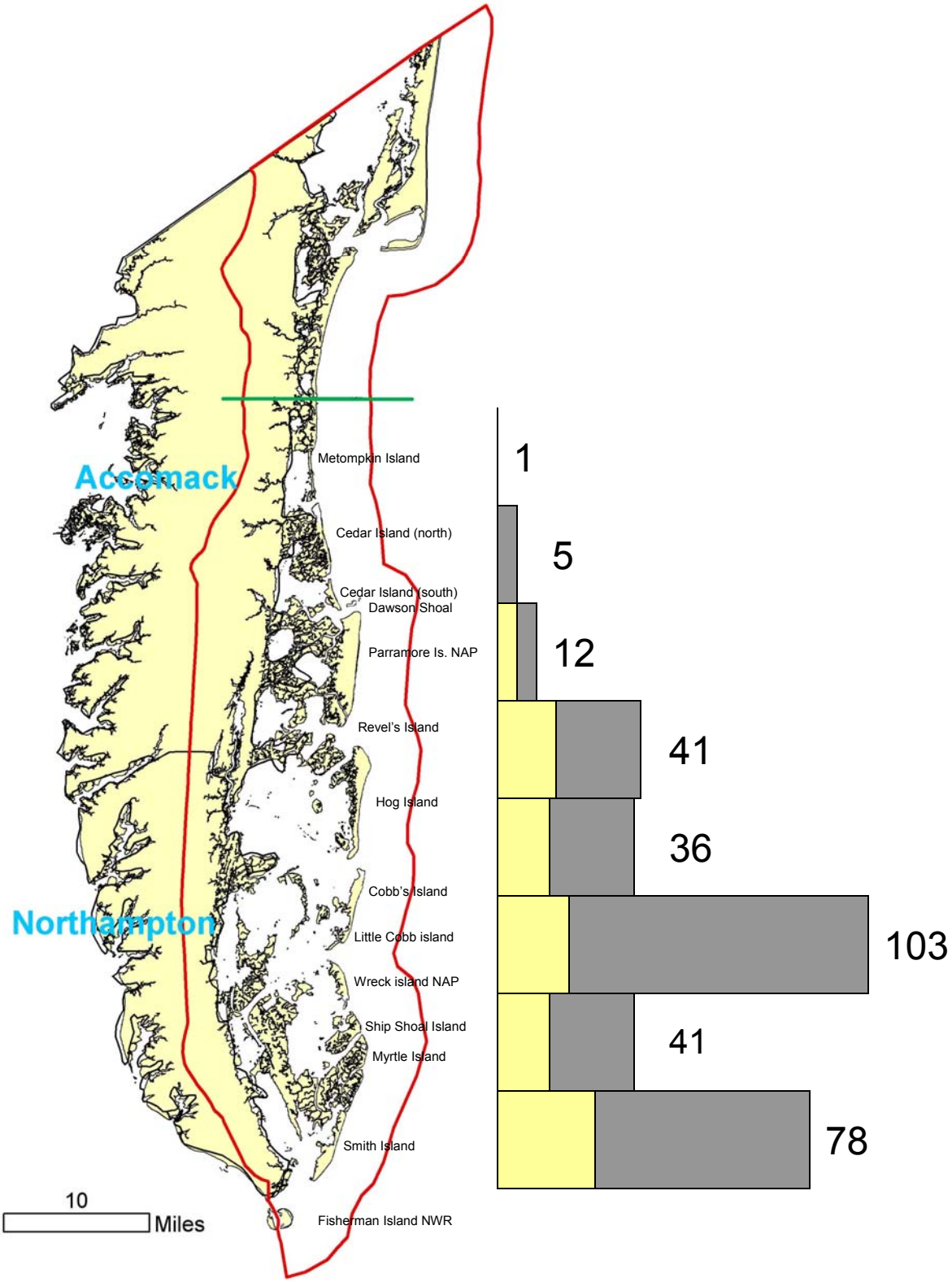

Figure 10. Average clam net distribution on barrier island beaches for 2004. Map of the Eastern Shore of Virginia. Red outline defines Seaside Heritage program area. Bar graph shows average clam net distribution in five nautical mile intervals. Number shows total average number per five nautical miles. Tan area indicates portion of white net. Gray area indicates portion of black net. One nautical mile equals 1852 meters

Island collectively had only 20 pieces of clam net. This low number is consistent with the lower number of clam beds from Parramore Island northward.

There was no evidence of clam net disrupting or disturbing any nesting birds. In two observed cases, two different birds were observed nesting on the net. Due to research permit restrictions, only nesting birds on Wreck Island NAP were observed during nesting season. In Figure 11, a Royal Tern nested on a small piece of white net near many other nests on the normal shell/sand strata. In Figure 12 a gull, possibly a herring gull, built a nest on the upper beach that was on a medium sized piece of clam net. In most cases, the clam net was carried or moved on and around the beach as part of the wrack. Two nets were observed working free from the wrack in 10-15 knot winds. Once free, the movement of the net could best be described as "tumble-weed" like. The free net balled up and moved short distances by wind until it snagged on debris or shells.

Figure 11. Royal Tern nest with egg on clam net on Wreck Island NAP. Photo color enhanced. (2003)

Figure 12. Gull nest with egg on clam net on Wreck Island NAP. Photo color enhanced.

Clam net found during the survey was remarkably clean. This was apparently due to the agitation of the net while floating in the sea and washing up on the beach. Nets removed from clam beds by growers are usually heavily encrusted with a variety of organic growth. During the survey, only 6 pieces of net on barrier beaches were encrusted with heavy growth.

The wrack line, consisting primarily of smooth cordgrass (*Spartina alterniflora*) stalks that had senesced and broken free in the fall, represented a clear indicator on most beaches as to the recent tides. The wrack line forms a narrow band of debris that was easy to follow. Over the summer, several wrack lines formed marking the higher tides down to the most recent tide. This was not observed in the spring survey, primarily due to the extreme tides during hurricane Isabel in September 2003. Only six percent of the net was observed seaward of this line (Figure 13). Within the wrack line, fresh, unmarked net was primarily located following initial surveys. This was also where most fresh trash and flotsam were located.

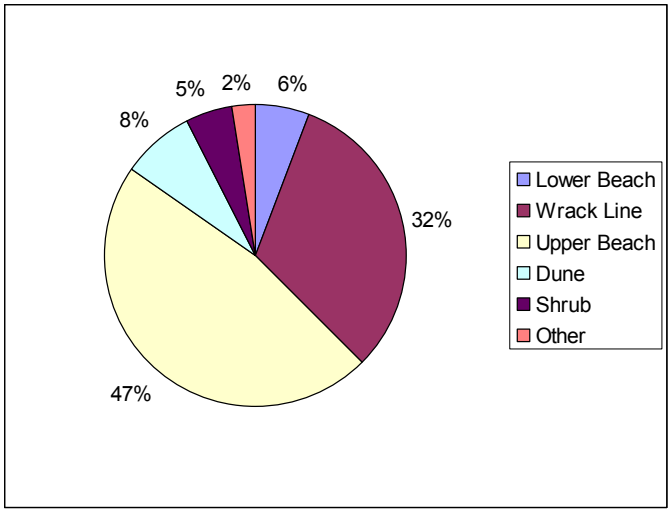

Figure 13. Percentage breakdown of observed clam netting by location.

Clam net on the upper beach held blowing sand. In just a few days some net was 50 percent covered with sand. During the detailed survey on Wreck Island NAP, fourteen tagged clam nets were completely buried over the summer. An estimated eight additional nets were probably buried over the summer but were never re-located under sand and vegetation. Figure 14 shows one piece that was buried and re-exposed in the fall in a small dune scarp, still partially buried. The heavy grass shown was not present when the net was first sampled. Over the summer, the entire wrack line was completely covered with sand. The net was not observed again until late summer, when erosion caused the scarp and re-exposed the net with the tag and flagging still intact.

Figure 14. Clam net exposed in beach scarp. Yellow box highlights area of clam net

Over the summer, clam net and wrack collected sand and began to support plants. Although clam net held sand, so did virtually everything else on the beach. Everything from tree stumps to abandoned crab pots acted as a mechanism for holding blowing sand. By far the most efficient sand collector was the smooth cordgrass wrack. Under the right conditions, the natural wrack lines could be 90 percent covered with sand in a few days.

A variety of plants were observed growing in, among and through the clam netting (Figure 15). Plant types were most often a result of where on the beach strand the net was located. The most common plant found growing in net collected soils was sea rocket (*Cakile edentula*) (Figure 16).

Figure 15. American beach grass (*Ammophila breviligulata*) growing among clam net and wrack.

Figure 16. Sea rocket (*Cakile edentula*) growing in sand trapped by clam net.

The amount of net on the island beaches varied slightly from the total number of nets, or portions of net observed. To determine the square footage of net, an average net dimension of 14 feet by 50 feet was used for a total of 700 square feet. Very small pieces of net, less than I meter square were not sampled. Of the nets sampled, the following values were assigned; Small (S) = 0.25, Medium (M) = 0.50, Large (L) = 0.75 and whole net = 1.00. The total average square footage was the total of all the values given, per island, multiplied by 700 square feet. On nets sampled more than once and measured in different sizes, the larger value sampled was used. For example, a net observed in the spring as Large/0.75 and sampled again in the fall as a Medium/0.50 was valued as a 0.75, the larger of the two samples. Table 3 shows the average distribution of individual pieces of net and the estimated square footage of net per island. Island size and physical makeup varies from island to island and may influence localized distribution.

Location	Pieces	Square Footage			Pieces	Square Footage
Metompkin Island	1	175		Cobb's Island	40	14700
Cedar Island (north)	3	1050		Little Cobb Island	13	3500
Cedar Island (south)	2	875		Wreck Island NAP	71	23800
Dawson Shoal	0	0		Ship Shoal Island	15	4550
Parramore Island	12	4200		Myrtle Island	15	4900
Revel's Island	2	525		Smith Island	84	34650
Hog Island	64	26600				
				Totals	322	119525

Table 3. Average distribution of individual pieces and the estimated square footage of net per island.

DISCUSSION

NET: The clam growers need the clam nets to protect their clams. It is safe to say that cultured clams could not be planted, unprotected, in the wild and have survival rates that could sustain an industry on the Eastern Shore (Figure 17). The nets provide adequate and cost effective protection from most predators encountered on the seaside. To be effective, the nets must remain intact. Even a small tear of a few inches can allow some predators to devastate entire beds of clams. Growers have developed effective ways of securing their nets over the young clams to protect them. Despite the care given to ensure that nets are properly placed, nets are still damaged or destroyed by man-made and naturally occurring events.

Figure 17. Clam beds covered by net exposed at low tide.

Man-made events, primarily nets struck by boats or boat propellers, are the most frustrating to growers who feel they are the most avoidable. Some shallow water beds are damaged by passing boats several times a season. Often it appears to be a recreational boat operating in unfamiliar waters. Though there are no specific guidelines for growers to mark their grounds, most have some type of marking. Small PVC pipe and locally cut bamboo are the two most popular markers. Some growers mark every bed while others place a minimal amount of marks out. The amount of markings is largely up to the grower. Some feel that more marks will keep boats away while other growers use minimal marks to not attract attention to the beds.

Natural events can have an even larger impact over large numbers of clam beds. Storms, strong current and ice can have devastating impacts on clam beds. Storms can occur during any time of the year. The storms can produce relatively large waves in the shallow water bays. Wave action can both erode sand from and deposit sand on nets. Similarly, storms and normal astronomical tide cycles can produce above average tides & currents that can also erode and cover beds with sand. Eroded nets are essentially uncovered, allowing predators to freely feed on the young clams. This is primarily a concern in the warmer months when predator activity is highest. Sand deposition or burying is a year-round problem. Clams typically live in approximately three inches of sand. Although they can tolerate deeper sand cover for short periods and will often burrow deeper when stressed, clams will not survive if buried for long periods of time. In this case, the buried clam net prevents the clam from digging back to a more favorable depth near the surface. Buried nets need to be uncovered before the clams die. Digging out buried clam nets often uses hand labor or water pumps to wash and dig away the deposited sand. Because of the sheer weight of the sand on the net, some nets are torn during the process. Ice forming over clam beds can freeze to clam net during low tides and the rising tide can lift the net off the beds. This was reported in the Tom's Cove area near Chincoteague (conversation, VMRC officers).

Animals are reported to be adapting to the nets and the large concentration of food they cover. Anecdotal reports describe herring gulls grabbing net covering beds and “twisting” to tear a small hole in the net to access the clams. In nursery beds several varieties of young or small crabs work their way under the nets. Some growers even report that deer walking on the net can puncture the net and allow predators to enter.

PUBLIC PERCEPTION: As the clam industry has grown over the past ten years so have the complaints. Other than the generic complaints about watermen in general, aquaculture complaints seem to fall into three areas; 1) the clam bed obstructing the waterways, 2) the visual litter of the markers used to mark the clam beds and 3) the nets as litter on our shores and beaches.

Figure 18. Clam beds marked with PVC pipe in South Bay.

Complaints one and two I see as related and not a subject of this study. However, brief comments are given to help understand some of the public perception issues faced by the industry. Clam beds are best placed in permitted areas where the grower hopes the clams will grow to market size. For the most part, there is a very specific habitat requirement that represents a small percentage of total bottom land. Growers are constantly looking for additional land, but good growing land is limited. Virtually all growing land is in the shallow waters of the coastal bays and none is located in marked navigable channels. Many beds are located alongside of navigable waters and I believe boaters who stray from these channels can find themselves striking clam beds. Large areas of the seaside do not have marked waterways and many local boaters rely on personal knowledge to navigate safely. Where these locally known waterways include planted clams, a conflict will exist. Growers seem to respond to this by marking their beds with numerous markers. To the people with local knowledge of the waterway the markers can clearly mark the way. To the novice boater, even the best marked beds are often confusing or misleading (Figure 18). The visual pollution of the markers seems to primarily be a problem on the bayside where the waterfront property development is much denser. Complaints center around the aesthetics of the markers in an otherwise pristine view shed. There are many areas on the seaside where clam beds are heavily marked but few are visible from shore or from navigable channels and thus receive fewer complaints.

Figure 19. Two clam nets (black & white) and conch pot on Smith Island, Virginia

Discarded and abandoned clam net is a problem and is a primary reason this study was developed. In the fall 2002 complaints of clam net washing up seemed to explode (Figure 19). It was the topic of conversation at

most environmental gatherings. Field researchers on the barrier Islands were reporting the growing problem. Even the local newspapers were running occasional letters to the editor addressing or commenting on the netting. The non-profit organization, Citizens for a Better Eastern Shore (CBES), ran articles addressing the issue in the monthly newsletter to their membership. At the same time, CBES was in the process of helping to form the Virginia Eastern Shorekeeper program and, in the initial organizational meeting notes, identified discarded clam net as a target for action. During the regular meeting in 2002 of the Seaside Heritage partners, a program funded by the Virginia Coastal Program, the issue of the clam net was addressed and ultimately funded this study.

INDUSTRY RESPONSE: By the summer of 2003 the aquaculture clam industry on the Eastern Shore was changing culturally. The once fairly quiet companies were becoming more vocal as the tidal water quality was degrading to the point it was affecting their business. Northampton county's big three growers, Cherrystone Aqua Farms, H.M. Terry Company, Inc. and J.C. Walker Brothers, Inc., began to take a more public stand on water quality issues, particularly on Parting Creek in Willis Wharf where all of the seaside clam hatcheries were located. They understood that their industry needed to address the discarded clam net to help improve their public image. Although these larger growers were already doing their part to keep their clam nets accounted for, they voluntarily began discussions with other growers, environmental organizations, particularly The Nature Conservancy, and the Virginia Eastern Shorekeeper on cleaning up the netting. In October 2003 the Virginia Eastern Shorekeeper began this survey. Immediately, calls were received from the clam growers reporting discarded net and who the net might belong to. By November 2003 some growers were sending their crews out to look for and recover abandoned net, regardless of the origin. Public complaints continued and in the spring of 2004 eight of the larger clam grower on the Eastern Shore of Virginia ran two half page ads in the Eastern Shore News, a local newspaper (Figure 20) on June 9 & 16, 2004. The newspaper ad established a "Clam Net Hotline" and a phone and Fax number to report net. The Virginia Eastern Shorekeeper provided the Fax number for the growers to advertise.

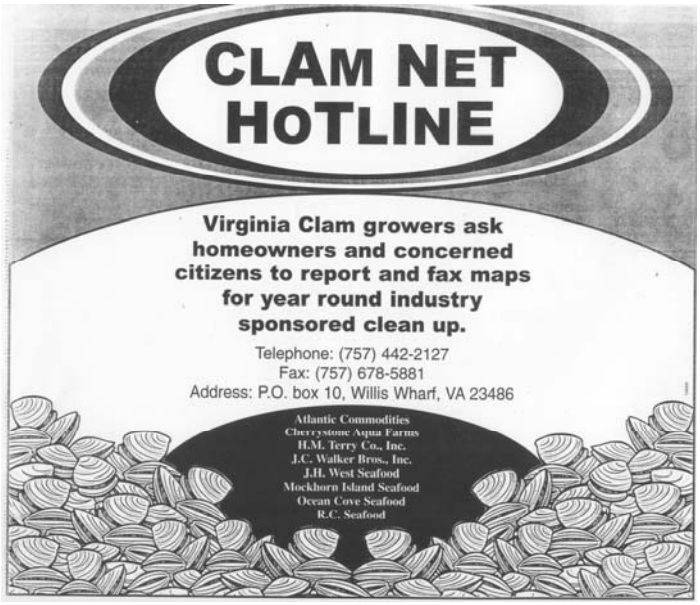

Figure 20. Image of "Clam Net Hotline" newspaper add from the Eastern Shore News.

Ironically, by October 2004 the Clam Net Hotline had only received two complaints of discarded clam net. Though I did not believe the Clam Net Hotline would receive many calls two calls surprised me. Since beginning the survey growers routinely contact me to report where they see abandoned net and the efforts they have made. Growers have been reluctant to report the names of other growers though they have indicated clearly who it was not.

The aquaculture industry reports some netting is lost during storm and unusual tide events. The quantity reported lost appears significantly less than the actual netting deposited along the shoreline (Figure 21). Discounting weather, the vast majority of the growers believe the net is being abandoned by less the ten percent of the total growers. Some have even reported hearing one of these growers say "he has never brought in a net." The larger growers, some of their co-op growers and several independent growers publicly condemn the practice of discarding net. They all indicated that a relatively small number of growers are creating a bad image for the rest of the industry.

It is illegal to discard any plastic from a boat. The Code of Federal Regulations, 33CFR151.67 Discharge of plastic prohibited, states; *"No person on board any ship may discharge into the sea, or into the navigable waters of the United States, plastic or garbage mixed with plastic, including, but not limited to, synthetic ropes,*

synthetic fishing nets, and plastic garbage bags. All garbage containing plastics requiring disposal must be discharged ashore or incinerated."

It is widely believed that most of the discarded clam net is abandoned at or near the clam beds and not discarded from the boat. Growers who remove nets from the clam beds to harvest the clams or maintain the nets simply pile the nets up near the site and let the tide carry them away. Abandoned net would be an enforcement problem. There is no state or federal law that would prohibit a grower from "storing" the used net near a bed until he had time to return to recover it. An enforcement agent would then have to prove intent to abandon the plastic net. This would be a very difficult case to prove in a court of law.

The aquaculture clam industry realizes it may be at, or near the market peak for hard shell clams on the Eastern Shore of Virginia. The limitation of desirable bottom land for planting and decreasing water quality along the Chesapeake bayside creeks are physical barriers to the industry. Market pressures and competition from other states also are limiting expansion.

RECOMMENDATIONS

There is momentum within the clam aquaculture industry to clean up abandoned clam net. This industry effort should continue to be supported. The larger clam growers clearly understand that their positive actions in minimizing or curtailing discarded and abandoned clam net will help eliminate the need for any regulatory mandates that may add unwanted costs to the industry. Expanding the Shorekeeper's visibility in monitoring the industry could be the most cost effective deterrent. In addition, educating the smaller growers using non-confrontational methods, as to the effects they are having on the industry may also help to reduce this form of pollution.

Figure 21: Freshly washed up clam net on Wreck Island NAP. Photo color enhanced.

The environmental impacts of discarded clam net need further study. Though this preliminary study seems to suggest that the netting on the barrier beaches has minimal short term environmental impact, much is still unknown. Additional monitoring to assess the nets' impact across the entire habitat is needed. In addition, little is known about the net longevity underwater and exposed as the netting is moved around by weather.

Convoluted laws and regulations currently govern this part fishery / part agricultural industry. Clarification is needed to specifically address gear used for aquaculture. Nearly all the current aquaculture regulations pertain to aquaculture fish farming conducted on closed ponds. Clams and the potential for large scale oyster farming in Virginia need clear guidance. To some extent, even the clam aquaculture industry wants regulatory help in protecting the area directly above their clam beds. Larger growers are advocating the need for their bottom leases to include all or part of the water column over their bottom leases. This idea is used, in various forms, in other states. There are opponents who fear this type of regulation could allow growers to "fence-off" large portions of the water. More discussion is needed.

Specific recommendations fall into three groups; education, monitoring and long range efforts.

1. **Education:**

    - Educate all growers on the negative impact the discarded clam netting is having on the industry. Though most violators know what they are doing is wrong, they may not understand the effect it is having on the industry.
    - Locate growers who knowingly discard or abandon plastic clam net into the water. Use a non-confrontational approach to contact growers who are observed discarding or abandoning net. Provide a background from the ongoing study and advise that their activities are being monitored.
    - Develop a handout that can be distributed to individual workers. It should be small and bilingual and it should be reviewed by the industry. Ideally distribution would be done by the larger growers to their employees and to their coop growers. Distribution to the independent and private growers would be done by the Shorekeeper.
    - Educate citizens as to the economic importance of clam aquaculture to the Eastern Shore of Virginia.

2. **Monitoring:**

    - Continue monitoring the amount of discarded and abandoned clam netting within the Seaside Heritage area.
    - Continue to monitor for environmental impacts of discarded and abandoned clam netting. Expand monitoring to include impacts on the salt marsh.
    - Begin to understand the effects of weather. Establish plots on random clam beds to determine some of the short term effects of storms and seasonal weather on clam nets.
    - Establish net plots on barrier beaches to assess the longevity of clam netting in the open environment and once trapped by sand. This will require monitoring well beyond one year.
    - Identify potential sources of discarded and abandoned netting. Overtly and covertly observe the planting and harvesting process to assess when net is most likely discarded.

3. **Long range planning:**

    - Continue to facilitate discussions with the aquaculture industry on the best ways to reduce the amount of net.
    - Continue to support the aquaculture industry with its efforts to clean up discarded net.
    - Review current laws and regulations with enforcement agencies. Look for gaps in laws and regulations.
    - Track the industry's efforts to develop legislation to protect the area directly above the planted clam beds.

This report of findings will be provided to the Virginia Department of Environmental Quality, Virginia Coastal Program and to all partners and landowners who had surveys conducted. All data and photographs not included in the report of findings shall be retained by the Virginia Eastern Shorekeeper for 3 years and is available to all partners.

ACKNOWLEDGEMENT

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